

Development of a soft X-ray ptychography beamline at SSRL and its application in the study of energy storage materials

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Ptychography is an emerging high resolution coherent imaging technique which can improve the resolution of scanning transmission X-ray microscopy (STXM) by over ten-fold. Development of this capability is underway at SSRL to establish sub-5 nm resolution in situ ptychography with near-edge X-ray absorption fine structure (NEXAFS) imaging. This is being achieved via an upgrade of the current soft X-ray STXM chamber on beamline 13-1, involving the installation of an area detector and an interferometer system for high precision sample motor control. The undulator source on beamline 13-1 provides the spatially and temporally coherent X-ray beam required for ptychographic imaging in the energy range 500 – 1200 eV. This energy range allows access to the oxygen chemistry and the valence states of 3d transition metals found in energy storage materials, making soft x-ray ptychography a particularly powerful tool to study the chemical states and structure of battery materials at relevant length scales. The implementation of in situ ptychographic imaging can therefore provide a wealth of additional information on battery operation and failure, with measurements possible at comparable imaging resolutions to TEM with a lower radiation dose. The development of this in situ ptychography capability will be described, along with its application to the study of energy storage materials.